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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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| In Re Application of: | |
| Thomas C. Anthony | Examiner: Kielin E. |
| Application No: 09/492,557 | Art Unit: 2813 |
| Filed: 1-27-2000 | |
| For: MAGNETIC MEMORY WITH STRUCTURES THAT PREVENT DISRUPTIONS TO MAGNETIZATION IN SENSE LAYERS | |

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Paul H. Horstmann
Name of Person Mailing Correspondence

Paul H. Horstmann 12-3-03
Signature Date

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

## Appellant's Brief (Pursuant to 37 C.F.R. §1.192)

Dear Sir:

Applicant/Appellant submits this Appeal Brief in connection with the above-referenced patent application which is on appeal to the Board of Patent Appeals and Interferences.

## TABLE OF CONTENTS

## REAL PARTY IN INTEREST

The real party in interest in this application is Hewlett-Packard Development Company, L.P.

## RELATED APPEALS AND INTERFERENCES

Appellant is unaware of any other related appeals or interferences that may directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

## STATUS OF THE CLAIMS

Claims 34-36, 38, and 40-41 stand rejected under §102(b) as being unpatentable over U.S. Patent No. 5,748,524 of *Chen et al.* ("*Chen*") and a publication entitled *Introduction to the Theory of Ferromagnetism*, Clarendon Press: Oxford, 1996, p. 16 by *Aharoni* ("*Aharoni*"). [1]

Claims 34, 37, and 39 stand rejected under 35 U.S.C. §102(e) as being unpatentable over U.S. Patent No. 5,956,267 of *Hurst et al.* ("*Hurst*").

Claims 34, 37, and 39 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Hurst* and *Chen*.

Claim 42 stands rejected under 35 U.S.C. §103(a) as being unpatentable over *Chen* and U.S. Patent No. 5,587,943 of *Torok et al.* ("*Torok*").

Appellant appeals the rejection of all of the pending claims 34-42. Claims 34-42 as currently pending are set forth in the attached Appendix.

## STATUS OF AMENDMENTS

Appellant is unaware of any amendments filed after the Final Office Action mailed 6/3/03 which finally rejected claims 34-42.

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[1] The Examiner has stated that *Aharoni* has been cited for the purpose of providing evidence that a structure disclosed by *Chen* possesses an inherent property and that the combination of *Chen* and *Aharoni* should not be construed as an obviousness rejection. (See the paragraph overlapping pages 8-9 of the Office Action mailed 6-3-03).

## SUMMARY OF THE INVENTION

Claims 34-42 are directed to a magnetic memory cell that includes a keeper structure having a proximity to a sense layer of the magnetic memory cell that provides a flux closure path between a pair of edge regions of the sense layer and that also applies magnetic fields using exchange coupling to the edge regions of the sense layer.

## ISSUES PRESENTED

**I: Whether claims 34-36, 38, and 40-41 are anticipated by *Chen*.**

**II: Whether claims 34, 37, and 39 are anticipated by *Hurst*.**

**III: Whether claims 34, 37, and 39 are obvious in view of *Hurst* and *Chen*.**

**IV: Whether claim 42 is obvious in view of *Chen* and *Torok*.**

## GROUPING OF CLAIMS

Claims 34-42 stand together (Group I).

## ARGUMENT

### I: Claims 34-36, 38, and 40-41 are not anticipated by *Chen* because *Chen* does not disclose the limitations of claim 34.

Appellant respectfully submits that claim 34, and claims 35-36, 38, and 40-41 which depend from claim 34, are not anticipated by *Chen* because *Chen* does not disclose a magnetic memory cell having a keeper structure that provides a flux closure path between a pair of edge regions of a sense layer of the magnetic memory cell as claimed in claim 34. Furthermore, *Chen* does not disclose a keeper structure that applies magnetic fields to the edge regions of the sense layer of the magnetic memory cell as claimed in claim 34.

### A. *Chen* does not disclose a keeper structure that provides a flux closure path between a pair of edge regions of a sense layer as claimed in claim 34.

Appellant submits that *Chen* does not disclose a keeper structure that provides a flux closure path between the edge regions of a sense layer as claimed in claim 34. Instead, *Chen* discloses a pinning material 30 that consists of two physically separate structures[2] - one structure disposed on each edge region of a magnetic layer 23 of a magnetic memory cell 20. (See Figs 5 and 6 of *Chen*). Appellant respectfully submits that the pinning material 30 disclosed by *Chen* cannot provide a flux closure path between edge regions of a sense layer as claimed in claim 34 because Figs 5 and 6 of *Chen* clearly show that the pinning material 30 consists of two physically separate structures that do not provide a path between the edge regions of the magnetic layer 23.

The Examiner has cited col. 4, lines 41-44 of *Chen* in support of his assertion that the pinning material 30 provides a flux closure path between

[2] *Chen* unfortunately refers to two physically distinct pinning material structures with the same reference number 30. Figs 5 and 6 of *Chen* clearly show that the pinning material 30 that pins the end vector 28 is a physically separate structure from the pinning material 30 that pins the end vector 29. (See *Chen*, col. 4, lines 48-52).

edge regions of a sense layer. (See pages 2-3, Office Action, 6-3-03). The section of *Chen* cited by the Examiner is as follows:

> Generally, it is desirable to pin magnetic end vectors 28 and 29 in an orientation substantially perpendicular to the length, or parallel to width W so as to reduce the end effects and at least partially close the magnetic loops.

(*Chen*, col. 4, lines 41-44). The Examiner has stated with respect to this cited section of *Chen* that

> Because the "magnetic loops" are the magnetic field lines -i.e. magnetic flux path – the magnetic flux path is closed.

(Pages 8, Office Action, 6-3-03).

Appellant respectfully submits that any magnetic loops in the magnetic layer 23 of *Chen* that are closed by the pinning material 30 are magnetic loops that are confined to the respective edge regions of the magnetic layer 23 and not magnetic flux between edge regions as claimed in claim 34 because the pinning material 30 of *Chen* actually consists of two physically separate structures that cannot carry magnetic flux between the edge regions.

### B. *Chen* does not disclose a keeper structure that applies magnetic fields to the edge regions of a sense layer as claimed in claim 34.

Appellant submits that *Chen* does not disclose a keeper structure that applies magnetic fields to a pair of edge regions of a sense layer as claimed in claim 34. The keeper structure of claim 34 applies magnetic fields to a pair of edge regions of a sense layer while also providing a flux closure path between the edge regions of the sense layer. In contrast, pinning material 30 of *Chen* consists of separate pinning material structures (See Figs 5-6 and col. 4, lines 58-63 of *Chen*) that pin respective each edge regions of a magnetic layer 23 (*Chen*, col. 4, lines 48-52). As shown above, the pinning material 30 of *Chen* does not provide a flux closure path between edge regions as does a keeper structure as claimed in claim 34.

## II: Claims 34, 37, and 39 are not anticipated by *Hurst* because *Hurst* does not disclose the limitations of claim 34.

Appellant respectfully submits that claim 34, and claims 37 and 39 which depend from claim 34, are not anticipated by *Hurst* because *Hurst* does not disclose a magnetic memory cell that includes a keeper structure having a proximity to a sense layer of the magnetic memory cell that provides a flux closure path between a pair of edge regions of the sense layer as claimed in claim 34. Moreover, *Hurst* does not disclose a keeper structure that applies magnetic fields to the edge regions of the sense layer as claimed in claim 34. Furthermore, *Hurst* does not disclose a keeper structure that applies magnetic fields using exchange coupling to the edge regions of the sense layer as claimed in claim 34.

### A. *Hurst* does not disclose a keeper structure having a proximity to a sense layer that provides a flux closure path between a pair of edge regions of the sense layer as claimed in claim 34.

Appellant submits that *Hurst* does not disclose a keeper structure that provides a flux closure path between the edge regions of a sense layer as claimed in claim 34. Instead, *Hurst* discloses a keeper that concentrates flux generated in the word line onto a bit region. (*Hurst*, col. 6, line 65 through col. 7, line 15). For example, *Hurst* discloses a magnetic field keeper 122 that surrounds a word line 120 (Fig. 16 of *Hurst*) and states that

> By providing a magnetic field keeper on the side walls 126a and 126b, the magnetic field 130 is even more effectively concentrated above the word line 120, thereby further increasing the magnetic field 130 at a bit region 132.

(Hurst, col. 7, lines 10-14).

Moreover, the keeper of *Hurst* does not have a proximity to a sense layer that provides a flux closure path between edge regions of the sense layer as claimed in claim 34. Instead, the keeper of *Hurst* is spaced a distance away from a bit region of a magnetic memory. For example, Fig. 16 of *Hurst* shows a magnetic field keeper 120 that is spaced a distance away from a bit region 132 and that does not overlap the edge regions of the bit region 132 in a

manner that would provide a flux closure path between the edge regions as claimed in claim 34. Similarly, Fig. 13 of *Hurst* shows a U-shaped keeper that is spaced a distance away from a bit region by an intervening dielectric layer and that does not overlap the edge regions of the bit region[3].

## B. *Hurst* does not disclose a keeper structure that applies magnetic fields to the edge regions of a sense layer as claimed in claim 34.

Appellant submits that *Hurst* does not disclose a keeper structure that applies magnetic fields to a pair of edge regions of a sense layer as claimed in claim 34. Instead, *Hurst* discloses a keeper that concentrates flux generated in a word line onto a bit region. (*Hurst*, col. 6, line 65 through col. 7, line 15).

The Examiner on page 9 of the Office Action mailed 6-3-03 has cited col. 7, lines 32-47 of *Hurst* in support of his assertion that *Hurst* discloses a keeper structure that applies magnetic fields to the edge regions of a sense layer. The cited section of *Hurst* includes the following

> it is contemplated that a reset line of a magnetic field sensor device may include the above-described magnetic field keeper to increase the magnetic field produced by the reset line <u>at the magnetic material of the sensor device</u>.

(Hurst, col. 7, lines 43-47) (emphasis added).

Appellant respectfully submits that a keeper that applies a magnetic field to reset the magnetic material of a magnetic field sensor device as taught by *Hurst* does not anticipate a keeper that applies magnetic fields to the edge regions of the sense layer of a magnetic memory cell as claimed in claim 34 because the keeper of *Hurst* acts as a flux concentrator. (*Hurst*, col. 6, line 65 through col. 7, line 15). It is submitted that any attempt to use the keeper of *Hurst* to apply magnetic fields to the edge regions of a sense layer in a

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[3] *Hurst* does not provide reference numbers in Fig. 13. However, *Hurst* states that Fig. 13 is analogous to Fig. 8 (*Hurst*, col. 6, lines 55-57). Fig. 8 of *Hurst* shows a bit region 70. In addition, Fig. 7 of *Hurst* which depicts an earlier step in the formation of the structure of Fig. 8 provides a reference number for a dielectric layer 60 that separates the bit region 70 from the remainder of the structure including the keeper 30. It should be noted that the keeper 30 is incorrectly referenced in Fig. 7 because the number 30 points to the dielectric layer 10 that encloses the keeper 30. The keeper 30 is referenced correctly in Fig. 6 of *Hurst*.

magnetic memory cell would, for example, wipe out any data stored in the sense layer of the magnetic memory cell.

### C. *Hurst* does not disclose a keeper structure that applies magnetic fields using exchange coupling to the edge regions of a sense layer as claimed in claim 34.

Appellant submits that *Hurst* does not disclose a keeper structure that applies magnetic fields using exchange coupling to a pair of edge regions of a sense layer as claimed in claim 34. Instead, *Hurst* discloses a keeper that is separated from a bit region by an intervening dielectric layer. (See the bit region 70 and dielectric layer 60 and keepers in Figs. 7-8 and analogous structures in Fig. 13 of *Hurst*).

The Examiner in support of his argument that *Hurst* discloses a keeper structure that uses exchange coupling to apply magnetic fields to edge regions has stated that

> Because the edge domains are magnetized in a particular direction by the keeper structure in Hurst, exchange coupling necessarily exists for reasons shown to be inherent by the Aharoni reference.

(Page 10, Office Action, 6-3-03) (emphasis added). The Examiner's argument based on *Aharoni* that exchange coupling inherently exists is as follows:[4]

> Note that "exchange" and "exchange energy" are defined in the text Introduction to the Theory of Ferromagnetism by **Aharoni**, ...to be the existence of a force for aligning the spins of unpaired electrons i.e. aligning the magnetic moments.

(Page 3, Office Action, 6-3-03) (emphasis original) ; and

> Accordingly, the ferromagnetic coupling is necessarily an example of "exchange coupling" by definition of exchange and exchange energy.

(Page 3, Office Action, 6-3-03).

Appellant respectfully submits that the definitions of "exchange" and "exchange energy" provided by the Examiner do not justify the conclusion that any type of ferromagnetic coupling, e.g. that shown in *Hurst*, is necessarily an example of "exchange coupling" as stated by the Examiner because what is missing from the definitions provided by the Examiner is the word "coupling."

Appellant's Specification provides illustrations of a keeper structure that is exchange coupled to a sense layer as claimed in claim 34 and a keeper structure that is not exchange coupled to a sense layer. For example, Fig. 1a of Appellant's Specification shows a keeper structure 56 exchange coupled to a pair of edge regions 157 and 158 and Appellant's Specification states that

> The sense layer 50 is directly exchange coupled to the keeper structure 56 at the edge regions 157 and 158. The sense layer 50 is influenced by the magnitude and direction of the magnetic anisotropy of the keeper structure 56.

(Page 10 of Appellant's Specification) and provides an alternative to exchange coupling by stating that

> Alternatively, the magnetic memory cell 40 is flipped over so that the reference layer 54 is adjacent to the keeper structure 56. The sense layer 50 is not exchange coupled to the keeper structure 56 but is influenced by the proximity of the permeable keeper structure 56 and no orthogonal field is generated in the edge regions 157-158.

(Page 10 of Appellant's Specification). In this alternative configuration in which the keeper structure 56 is not exchange coupled to the sense layer 50 but is instead separated from the sense layer 50 by a reference layer 54 is similar to the spacing between a keeper and a bit region taught by *Hurst*.

Therefore, Appellant submits that *Hurst* does not disclose a keeper structure that applies magnetic fields using exchange coupling to a pair of edge regions of a sense layer as claimed in claim 34 because the keeper of *Hurst* is not coupled to a bit region but is instead separated from a bit region by an intervening dielectric layer. (See the bit region 70 and dielectric layer 60 in Figs. 7-8 and analogous structures in Fig. 13 of *Hurst*).

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[4] The Examiner set forth this argument in rejecting claim 34 in view of Chen.

## III: Claims 34, 37, and 39 are not obvious in view of *Hurst* and *Chen* because *Hurst* and *Chen* do not disclose or suggest the limitations of claim 34.

Appellant respectfully submits that claim 34, and claims 37 and 39 which depend from claim 34, are not obvious in view of *Hurst* and *Chen* because *Hurst* and *Chen* do not disclose or suggest a magnetic memory cell that includes a keeper structure having a proximity to a sense layer of the magnetic memory cell that provides a flux closure path between a pair of edge regions of the sense layer as claimed in claim 34. Moreover, *Hurst* and *Chen* do not disclose or suggest a magnetic memory cell having a keeper structure that applies magnetic fields using exchange coupling to the edge regions of a sense layer of as claimed in claim 34. Furthermore, one of ordinary skill in the art would not be motivated to combine the teachings of *Hurst* and *Chen*.

### A. *Hurst* and *Chen* do not disclose or suggest the limitations of claim 34.

Appellant submits that *Hurst* and *Chen* do not disclose or suggest a magnetic memory cell that includes a keeper structure having a proximity to a sense layer of the magnetic memory cell that provides a flux closure path between a pair of edge regions of the sense layer as claimed in claim 34. Instead, *Hurst* discloses a (flux concentrator) keeper that lacks a proximity to a bit region that would provide a flux closure path between edge regions of the bit region (See Figs 13 and 16 of *Hurst)* and *Chen* discloses a pinning material 30 made up of physically distinct structures (Figs 5 and 6 of *Chen*) that cannot provide a flux closure path between edge regions.

Moreover, *Hurst* and *Chen* do not disclose or suggest a magnetic memory cell having a keeper structure that applies magnetic fields using exchange coupling to the edge regions of a sense layer of as claimed in claim 34. Instead, *Hurst* discloses a keeper that is separated from a bit region by an intervening dielectric layer (See the bit region 70 and dielectric layer 60 and

keepers in Figs. 7-8 and analogous structures in Fig. 13 of *Hurst*) rather than exchange coupled to the bit region and *Chen* discloses a pair of separate pinning material structures (See Figs 5 and 6 of *Chen*) rather than a keeper structure.

**B. One of ordinary skill in the art would not be motivated to combine the teachings of *Hurst* and *Chen* to apply magnetic fields to edge regions of a sense layer as claimed in claim 34.**

An obviousness rejection based on a combination of references is improper in the absence of a motivation to combine the references. In re Rouffet, 149 F.3d 1350, 1357, 47USPQ2d 1453, 1457-58 (Fed. Cir. 1998). Appellant respectfully submits that one of ordinary skill in the art would not be motivated to combine the teachings of *Hurst* with the teachings *Chen* because the motivation for the pinning material 30 of *Chen* is to pin only the end vectors 28 and 29 in the edge regions of a magnetic memory cell 20 (*Chen*, col. 4, lines 48-63) whereas the motivation for the keeper of *Hurst* is to concentrate magnetic flux from a word line onto an entire bit region. (*Hurst*, col. 6, line 65 through col. 7, line 15).

The mere fact that references can be combined does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). It is submitted that the teachings of *Hurst* and *Chen* would not suggest to one of ordinary skill in the art the desirability of combining the keeper of *Hurst* with the magnetic memory cell edge pinning of *Chen* because an attempt to use the keeper of *Hurst* to apply magnetic fields to the edge regions of a sense layer in a magnetic memory cell would wipe out any data stored in the sense layer of the magnetic memory cell and thereby undesirably destroy the utility of a magnetic memory.

## IV: Claim 42 is not obvious in view of *Chen* and *Torok* because *Chen* and *Torok* do not disclose or suggest the limitations of claim 34.

Appellant respectfully submits that claim 42 is not obvious in view of *Chen* and *Torok* because claim 42 depends from claim 34 and *Chen* and *Torok* do not disclose or suggest a magnetic memory cell having a keeper structure that provides a flux closure path between a pair of edge regions of a sense layer as claimed in claim 34. Instead, *Chen* discloses a pinning material 30 made up of physically distinct structures (Figs 5 and 6 of *Chen*) that cannot provide a flux closure path and *Torok* discloses GMR structures. (*Torok*, col. 3, lines 52-63). Furthermore, *Chen* and *Torok* do not disclose or suggest a keeper structure that applies magnetic fields using exchange coupling to the edge regions of a sense layer as claimed in claim 34.

## CONCLUSION

Appellant respectfully submits that the stated rejections cannot be maintained in view of the arguments set forth above. Appellant respectfully submits that all of the claims 34-42 are patentable under 35 U.S.C. §§102,103 over the references cited by the Examiner and requests that the Board of Patent Appeals and Interferences direct allowance of the rejected claims.

Respectfully submitted,

By

Date: 12-3-03

Paul H. Horstmann
Reg. No. 36,167

## APPENDIX

34. A magnetic memory, comprising:

magnetic memory cell including a sense layer having an easy axis;

keeper structure for applying magnetic fields using exchange coupling to a pair of edge regions of the sense layer that force magnetizations in the edge regions to have a substantially similar direction which is substantially perpendicular to the easy axis of the sense layer, the keeper structure having a proximity to the sense layer which provides a flux closure path between the edge regions.

35. The magnetic memory of claim 34, wherein the flux closure path between the edge regions prevents overall magnetization in the sense layer from straying from parallel and antiparallel orientations with respect to the easy axis of the sense layer.

36. The magnetic memory of claim 34, wherein the keeper structure has an easy axis which is substantially perpendicular to the easy axis of the sense layer.

37. The magnetic memory of claim 34, wherein the keeper structure has a U-shape including a pair of surfaces that overlap the edge regions and which are exchange coupled to the sense layer.

38. The magnetic memory of claim 34, wherein the keeper structure is formed from a permeable ferromagnetic material having an easy axis which runs along a length of the keeper structure in a direction substantially parallel to the edge regions.

39. The magnetic memory of claim 34, wherein the keeper structure encases a conductor that provides read and write access to the magnetic memory cell.

40. The magnetic memory of claim 34, further comprising a reference layer and a tunnel barrier between the sense layer and the reference layer of the magnetic memory cell.

41. The magnetic memory of claim 40, wherein the keeper structure is adjacent to the sense layer.

42. The magnetic memory of claim 40, wherein the magnetic memory cell has substantially square outer dimensions.